20

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(54) PRINTED MATTER AUTHENTICATING DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To prevent identification information embedded in a printed matter from being illegally read and the printed matter from being forged or altered by making mutually different a method for embedding the identification information into the printed matter and a method for extracting the identification information from the printed matter.
SOLUTION: This printed matter authenticating device is composed of an identification information embedding device for embedding the identification information into the printed matter and an identification information recognizing device for extracting the identification information from the printed matter and collating the information. The identification information embedding device is provided with an image input parta preprocessing partan array replacing part and an image output partand the identification information recognizing device is provided with an identification information extracting device for extracting the identification information and an identification information collating device for collating the extracted identification information with previously stored reference identification information data.

CLAIMS

[Claim(s)]
[Claim 1]It is a printed matter authentication device which comprises an

identification information recognition device which extracts and compares said identification information to printed matter from an identification information embedding device which embeds identification informationand said printed matterSaid identification information embedding device is provided with an image input parta pretreatment partan arrangement substitution partand an image output partand said image input partChange inputted image data respectively corresponding to n original image data (howevern>=1;n is taken as an integer.) into digital image datarespectivelyand n digital image data is inputtedAfter said pretreatment part's carrying out binarization of said n digital image datarespectively and creating n binary picturesExpand said n binary pictures in all directions for predetermined magnificationrespectivelycreate n expansion picturesand said arrangement substitution partBy creating two kinds of arrangement substitution pictures for every expansion picture of said n expansion picturesEmbed 1 bit of identification information in each kind of two kinds of said arrangement substitution pictures of arrangement substitution pictureand said image output partBy outputting image data of an arrangement substitution picture of one kind of said two kinds of arrangement substitution pictures for every expansion picture of said n expansion picturesand printing n arrangement substitution picturesIn totalproduce printed matter which embedded identification information of n bitand said identification information recognition deviceIt comprises an identification information collating unit which compares identification information of an identification information extracting apparatus which extracts identification information of said n bitand said extracted n bit with standard identification information data of n bit memorized beforehandSaid identification information extracting apparatus is provided with an image read sectionthe Fast Fourier Transform parta Fourier-spectrum extraction partand a Fourier-spectrum outputting partand said image read sectionChange into digital image data image data of said n arrangement substitution pictures read in said printed matterrespectivelyand n digital image data is generatedSaid Fast Fourier Transform partsaid Fourier-spectrum extraction partand said Fourier-spectrum outputting partSaid n digital image data generated by said image read section is processedrespectivelyExtract identification information of said n bit from said printed matter using a Fourier spectrum of each kind of two kinds of said arrangement substitution pictures of arrangement substitution picture having a mutually different deviation for every expansion picture of said n expansion picturesand said identification information collating unitStandard identification information data of identification information of said n bit extracted with said identification information extracting apparatus and said n bit is comparedA printed matter authentication device identifying said printed matter as genuine printed matter when a predetermined relation between identification information of said n bit and standard identification information data of said n bit is.

[Claim 2]Said image input part is provided with image input apparatus containing an image scanner or a video cameraThe printed matter authentication device according to claim 1 creating n inputted image data by incorporating said n original

image data using said image input apparatusrespectivelychanging said n inputted image data into digital image datarespectivelyand considering it as said n digital image data.
[Claim 3]Said pretreatment part carries out binarization of said n digital image data inputted from said image input partrespectivelyand creates said n binary picturesThe printed matter authentication device according to claim 1 or 2 expanding said n binary pictures in all directions at two timesrespectivelyand creating said n expansion pictures.
[Claim 4]Said arrangement substitution part divides into arrangement of 2x2 pixel units said n expansion pictures which are monochrome binary pictures which comprise a white picture element of a value of 1and a black pixel of a value of 0 for every expansion pictureIn arrangement of said all 2x2 pixel units for every expansion picture of said n expansion picturesTwo kinds of arrangement substitution picturesthe first arrangement substitution picture and the second arrangement substitution pictureare created by changing the number of said white picture elementand arrangement in accordance with a predetermined arrangement substitution ruleCharacter in which arrangement of said white picture element differs for every expansion picture of said n expansion pictures between said first arrangement substitution picture and said second arrangement substitution picture is used. The printed matter authentication device according to claim 3 embedding 1 bit of identification information in said first arrangement substitution picture and said second arrangement substitution picture.
[Claim 5]Said image output part is provided with image output equipment containing a printer or a printing machineBy outputting image data of an arrangement substitution picture of one kind of said two kinds of arrangement substitution pictures to the surface of a predetermined substrate for every expansion picture of said n expansion pictures using said image output equipmentThe printed matter authentication device according to any one of claims 1 to 4 printing n arrangement substitution pictures on the surface of said substrate.
[Claim 6]Said image read section is provided with image reading apparatus containing an image scanner or a video cameraBy reading an arrangement substitution picture of one kind of said two kinds of arrangement substitution pictures outputted to the surface of said substrate from said image output part for every expansion picture of said n expansion pictures using said image reading apparatusand changing into digital image dataThe printed matter authentication device according to any one of claims 1 to 5 generating n digital image data from said printed matter.
[Claim 7]The printed matter authentication device according to any one of claims 1 to 6wherein said Fast Fourier Transform part carries out Fast Fourier Transform of the n digital image data generated by said image read sectionrespectively and obtains n digital data.
[Claim 8]The printed matter authentication device according to any one of claims 1 to 7wherein said Fourier-spectrum extraction part extracts data of a Fourier

spectrum from said n digital data obtained in said Fast Fourier Transform partrespectively and obtains data of n Fourier spectra.
[Claim 9]The printed matter authentication device according to any one of claims 1 to 8 outputting said Fourier-spectrum outputting part to said identification information collating unit by using as binary data data of said n Fourier spectra obtained by said Fourier-spectrum extraction partrespectively.
[Claim 10]When the 2x2-pixel arrangement Ci (i= 12..5) is expressed as Ci= {P11P21P12P22} using the pixel value Pxy (x= 12;y=12) for every expansion picture of said n expansion picturessaid predetermined arrangement substitution rule C1= {0000}When defining it as C2= {1111}C3= {1000}C4= {1011}and C5= {1101} and creating said first arrangement substitution pictureThe printed matter authentication device according to any one of claims 4 to 9 characterized by transposing said C2 to said C5 after transposing said C1 to said C3when transposing said C2 to said C4 and creating said second arrangement substitution picture after transposing said C1 to said C3.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention relates to the printed matter authentication device which extracts and compares the predetermined identification information which embedded predetermined identification information at printed matterand was embedded at printed matterand attests printed matter.
It is the art which can be used for discernment of the printed matter containing a securitya billa stampan inspection stickera stampa passportan identification carda pass permita membership cardand a credit cardor truth distinction.

[0002]
[Description of the Prior Art]as for the embedding of identification informationand extraction of identification informationalthough each modulation method of amplitudefrequencyand a phase is proposed as identification information embedding art to a pictureit is common to adopt the same method. Among thesealthough there are the method (Japanese Patent Application No. No. 213540 [08 to]) of carrying out direct modulation by modulo arithmeticetc. as an example of embedding of the identification information using amplitude modulationif it is going to apply this to printed matterit will be limited to printing methodssuch as a sublimated type hot printing method in which intermediate color expression is possibleand photogravure. Since [which is depended on the density unevenness of inkor time progress] it fades and is easy to be influenced by illumination unevenness etc.it is difficult to be stabilized and to extract the embedded identification information.
[0003]The thing (NakamuraMatsui: "synthetic encoding method of shade image and

text data using discrete orthogonal transformation"IEICE TRANSACTIONSVol.J72-D-IINo.3and pp.363-368-1989) using orthogonal transformation as an example of embedding of the identification information by frequency modulation etc. are proposed. An embedded domain is limited by the pattern in order that this method may generally embed identification information into the complicated portion of a shade. When the embedded domain at the time of applying to printed matter is narrowand the portion has dirt and a blurextraction of identification information may become difficult.

[0004]There are what is depended on a concentration-patterns method (Japanese Patent Application No. No. 058617 [08 to])a thing (Japanese Patent Application No. No. 047310 [62 to]) to depend on a dither methodetc. in the example of embedding of the identification information using a phase modulation. Since these are methods which modulate the position of the pixel of the binary picture which changed concentration into densitythey are applicable to a broad printing method. When concentration gradation is changed appropriatelysince it becomes possible to embed identification information in the wide range of a pictureit is strong also to the dirt of printed matteror a blur. Howeverwhen extracting identification informationhighly precise alignment is needed. When extracting identification informationit is necessary to carry out binarization of the multi valued image inputted from an image scannera video cameraetc. butand if there are a fallillumination unevennessetc. of the sharpness of a multi valued imagea pixel value may be unable to be restored correctly.

[0005]

[Problem(s) to be Solved by the Invention]In the device which performs attestation of printed matterand truth distinction by extracting and comparing the predetermined identification information which this invention embedded predetermined identification information at printed matterand was embedded at printed matterWhen aiming at solving the above conventional problems and embedding identification information at printed matterWhen performing embedding of the identification information by the phase encoding using the character in which arrangement of the white picture element in predetermined pixel arrangement differs mutually among two kinds of arrangement substitution pictures and extracting identification information from printed matterThe method of extracting identification information using the character in which the deviations of a Fourier spectrum differ mutually among two kinds of arrangement substitution picturesand embedding identification information to printed matterand the method of extracting identification information from printed matter by considering it as a mutually different methodLet it be a technical problem to prevent the forgery of unjust reading of identification information and printed matter and alteration which were embedded at printed matter.

[0006]An object of this invention is to compare the identification information extracted from printed matter with the standard identification information data set up beforehandand to realize attestation of printed matter. Under the present circumstancesalthough the printed matter in which identification information was

embedded provides 1-bit information by one image data in this inventionLet it be a technical problem to realize the printed matter authentication device which compares many information with standard identification information dataand enables positive discernment of printed matterand truth distinction by embedding two or more bits identification information at printed matter using two or more image data.

[0007]

[Means for Solving the Problem]A printed matter authentication device of this invention is a printed matter authentication device which comprises an identification information recognition device which extracts and compares said identification information to printed matter from an identification information embedding device which embeds identification informationand said printed matterSaid identification information embedding device is provided with an image input parta pretreatment partan arrangement substitution partand an image output partand said image input partChange inputted image data respectively corresponding to n original image data (howevern>=1;n is taken as an integer.) into digital image datarespectivelyand n digital image data is inputtedAfter said pretreatment part's carrying out binarization of said n digital image datarespectively and creating n binary picturesExpand said n binary pictures in all directions for predetermined magnificationrespectivelycreate n expansion picturesand said arrangement substitution partBy creating two kinds of arrangement substitution pictures for every expansion picture of said n expansion picturesEmbed 1 bit of identification information in each kind of two kinds of said arrangement substitution pictures of arrangement substitution pictureand said image output partBy outputting image data of an arrangement substitution picture of one kind of said two kinds of arrangement substitution pictures for every expansion picture of said n expansion picturesand printing n arrangement substitution picturesIn totalproduce printed matter which embedded identification information of n bitand said identification information recognition deviceIt comprises an identification information collating unit which compares identification information of an identification information extracting apparatus which extracts identification information of said n bitand said extracted n bit with standard identification information data of n bit memorized beforehandSaid identification information extracting apparatus is provided with an image read sectionthe Fast Fourier Transform parta Fourier-spectrum extraction partand a Fourier-spectrum outputting partand said image read sectionChange into digital image data image data of said n arrangement substitution pictures read in said printed matterrespectivelyand n digital image data is generatedSaid Fast Fourier Transform partsaid Fourier-spectrum extraction partand said Fourier-spectrum outputting partSaid n digital image data generated by said image read section is processedrespectivelyExtract identification information of said n bit from said printed matter using a Fourier spectrum of each kind of two kinds of said arrangement substitution pictures of arrangement substitution picture having a mutually different deviation for every expansion picture of said n expansion

picturesand said identification information collating unitWhen standard identification information data of identification information of said n bit extracted with said identification information extracting apparatus and said n bit is compared and a predetermined relation between identification information of said n bit and standard identification information data of said n bit isit is characterized by identifying said printed matter as genuine printed matter.

[0008]A printed matter authentication device of this invention is provided with image input apparatus in which said image input part contains an image scanner or a video cameraIt is characterized by creating n inputted image data by incorporating said n original image data using said image input apparatusrespectivelychanging said n inputted image data into digital image datarespectivelyand considering it as said n digital image data.

[0009]Said pretreatment part carries out binarization of said n digital image data inputted from said image input partrespectivelyand a printed matter authentication device of this invention creates said n binary picturesIt is characterized by expanding said n binary pictures in all directions at two timesrespectivelyand creating said n expansion pictures.

[0010]A printed matter authentication device of this invention divides into arrangement of 2x2 pixel units said n expansion pictures in which said arrangement substitution parts are the monochrome binary pictures which comprise a white picture element of a value of 1and a black pixel of a value of 0 for every expansion pictureIn arrangement of said all 2x2 pixel units for every expansion picture of said n expansion picturesTwo kinds of arrangement substitution picturesthe first arrangement substitution picture and the second arrangement substitution pictureare created by changing the number of said white picture elementand arrangement in accordance with a predetermined arrangement substitution ruleIt is characterized by embedding 1 bit of identification information for every expansion picture of said n expansion pictures using character in which arrangement of said white picture element differsin said first arrangement substitution picture and said second arrangement substitution picture between said first arrangement substitution picture and said second arrangement substitution picture.

[0011]A printed matter authentication device of this invention is provided with image output equipment in which said image output part contains a printer or a printing machineBy outputting image data of an arrangement substitution picture of one kind of said two kinds of arrangement substitution pictures to the surface of a predetermined substrate for every expansion picture of said n expansion pictures using said image output equipmentit is characterized by printing n arrangement substitution pictures on the surface of said substrate.

[0012]A printed matter authentication device of this invention is provided with image reading apparatus by which said image read section contains an image scanner or a video cameraBy reading an arrangement substitution picture of one kind of said two kinds of arrangement substitution pictures outputted to the surface of said substrate from said image output part for every expansion picture of said n expansion pictures using said image reading apparatusand changing into

digital image dataIt is characterized by generating n digital image data from said printed matter.
[0013]A printed matter authentication device of this invention is characterized by said Fast Fourier Transform part's carrying out Fast Fourier Transform of the n digital image data generated by said image read sectionrespectivelyand obtaining n digital data.
[0014]A printed matter authentication device of this invention is characterized by said Fourier-spectrum extraction part's extracting data of a Fourier spectrum from said n digital data obtained in said Fast Fourier Transform partrespectivelyand obtaining data of n Fourier spectra.
[0015]A printed matter authentication device of this invention is characterized by said Fourier-spectrum outputting part outputting to said identification information collating unit by using as binary data data of said n Fourier spectra obtained by said Fourier-spectrum extraction partrespectively.
[0016]A printed matter authentication device of this invention said predetermined arrangement substitution ruleWhen the 2x2-pixel arrangement Ci (i= 12..5) is expressed as Ci= {P11P21P12P22} using the pixel value Pxy (x= 12;y=12) for every expansion picture of said n expansion picturesC1= {0000}C2= {1111}C3= {1000}When defining it as C4= {1011} and C5= {1101} and creating said first arrangement substitution pictureWhen transposing said C2 to said C4 and creating said second arrangement substitution pictureafter transposing said C1 to said C3after transposing said C1 to said C3it is characterized by transposing said C2 to said C5.
[0017]
[Embodiment of the Invention]Although the embodiment of the printed matter authentication device concerning this invention is hereafter described with reference to drawings based on an exampleThe mode of operation of the printed matter authentication device concerning this invention is not limited to the example shown belowand if it is within the limits of the technical matter indicated to the claim concerning this inventionit can adopt various kinds of modes.
Although especially the case where create two kinds of arrangement substitution pictures from the expansion picture acquired in the following examples by expanding the binary picture corresponding to original image data to two times in all directionsrespectivelyand 1 bit of identification information is embedded in each kind of two kinds of arrangement substitution pictures of arrangement substitution picture is explainedIn accordance with a predetermined arrangement substitution ruletwo kinds of arrangement substitution pictures are created from the expansion picture acquired by expanding the binary picture corresponding to original image data for predetermined magnification for every directionIt is also possible by embedding 1 bit of identification information in each kind of two kinds of arrangement substitution pictures of arrangement substitution picture to constitute the printed matter authentication device of this invention.
[0018](Printed matter authentication device whole) Drawing 1 is a figure for explaining the entire configuration of the example of the printed matter

authentication device concerning this invention. Image data which embedded identification information as the printed matter authentication device concerning this invention was shown in drawing 1 (in this example.) They are "arrangement substitution picture" I mentioned later – NI. Identification information is extracted from the identification information embedding device which produces the printed matter in which it outputted and identification information was embeddedand printed matter. It comprises an identification information recognition device to compare (carry out discernment of printed matterand truth distinction as compared with the standard identification information data beforehand set up in the contents of identification information.). And the identification information recognition device comprises an identification information collating unit which compares the identification information extracting apparatus which extracts and outputs identification informationand the extracted identification information with the standard identification information data set up beforehand.

[0019]Herewhen the identification information embedding device which constitutes the printed matter authentication device concerning this invention produces the printed matter which embedded identification informationit is needed. And when the identification information recognition device which constitutes the printed matter authentication device concerning this invention attests the printed matter in which identification information was embeddedit is needed.

[0020]The identification information embedded in the printed matter authentication device concerning this invention at printed matter is n pieces (howevern>=1;n is taken as an integer.). Hereafternis defined in a similar manner. It is constituted by image data and 1 bit of identification information can be embedded at printed matter using one image data. Thereforeit becomes possible to extract the identification information of n bit from the printed matter in which n image data is printed.

[0021]In the example shown by drawing 1in an identification information embedding devicefour image data of arrangement substitution picture I later mentioned as identification information – NI is outputted on a predetermined substraterespectivelyand printed matter is produced. And in an identification information extracting apparatusafter extracting identification information from four image data read in printed matterrespectivelybinarization of the extracted identification information is carried outand 4-bit identification information is outputted. Nextthe outputted 4-bit identification information is compared with the standard identification information data beforehand memorized in the identification information collating unitand discernment and recognition of the identification information extracted by carrying out truth distinction are performed in the contents.

[0022]The feature of the printed matter authentication device concerning this invention is the following point.

(1) In the printed matter authentication device concerning this inventionthe method of embedding identification information at printed matter differs from the method of extracting the identification information embedded at printed matter.

Thereforewhen identification information is embedded at printed matterthe identification information embedded at printed matter cannot be grasped only by reading n image data printed by this printed matter. That isaccording to the printed matter authentication device concerning this inventionthe printed matter in which the identification information kept secret was embedded is producible. The method of embedding identification information with an identification information embedding device and how an identification information extracting apparatus extracts identification information are explained in detail later.

[0023](2) In the printed matter authentication device concerning this inventionone image data printed by printed matter provides 1 bit of identification information. Thereforewhen printing n image data and embedding the identification information of n bit at printed matterit becomes possible to embed 2n a kind of identification information at printed matter. That iswhen the identification information of n bit is embedded at printed matterone image data printed by printed matter provides the 1-bit information which constitutes the identification information of n bit embedded at printed matter.

[0024]For examplewhen using the printed matter authentication device concerning this invention as an authentication device of a membership cardthe identification information of n bit can give a member's password. It may constitute from a membership card with a photograph so that 1 bit of identification information of the identification information of n bit may make it correspond with the personal characteristics (existence of glasses wearetc.) of the member who can grasp with a photograph and may be given.

[0025](Identification information embedding device) The concrete composition of the printed matter authentication device concerning this invention is explained hereafter. Firstthe identification information embedding device which embeds identification information at printed matter is explained.

[0026]Drawing 2 is a block diagram showing the example of the identification information embedding device of a printed matter authentication deviceand an identification information extracting apparatus concerning this invention. The identification information embedding device 1 shown in drawing 2 possesses the image input part 3the pretreatment part 4the arrangement substitution part 5and the image output part 6and the identification information extracting apparatus 2 possesses the image read section 7the Fast Fourier Transform part 8the Fourier-spectrum extraction part 9and the Fourier-spectrum outputting part 10.

[0027]The image input part 3 is provided with an image scannera video cameraetc.inputs the original image 11 and changes it into digital image data. The pretreatment part 4 carries out binarization of the digital image data of the original image 11creates a binary pictureafter thatexpands a binary picture to two times in all directionsrespectivelyand creates an expansion picture. In all the arrangement which divided the expansion picture into 2x2 pixel unitsthe arrangement substitution part 5 creates two kinds of arrangement substitution pictures by changing the number of the white picture element of the value of 1and arrangement in accordance with an arrangement substitution rule. These details

are explained in detail later.
[0028]By providing the image output part 6 with image output equipmentsuch as a printer and a printing machineand outputting n arrangement substitution pictures on the predetermined substrate which contains papera plasticmetaland clothrespectivelyThe printed matter containing a securitya billa stampan inspection stickera stampa passportan identification carda pass permita membership cardand a credit card is produced.
[0029](Identification information recognition device) An identification information recognition device comprises an identification information collating unit which compares the identification information extracting apparatus which extracts identification informationand the extracted identification information with the standard identification information data beforehand memorized by memory storage. The identification information extracting apparatus is provided with the image read sectionthe Fast Fourier Transform partthe Fourier-spectrum extraction partand the Fourier-spectrum outputting part.
[0030]In the identification information extracting apparatus 2 shown in drawing 2the image read section 7 is provided with an image scannera video cameraetc.reads an arrangement substitution picture in the printed matter 12 in which identification information was embeddedand changes it into digital image data. The Fast Fourier Transform part 8 carries out Fast Fourier Transform of the arrangement substitution picture changed into digital image data. The Fourier-spectrum extraction part 9 extracts a Fourier spectrum from the digital data (a real partimaginary parta phasea Fourier spectrum) obtained by carrying out Fast Fourier Transform of the arrangement substitution picture.
[0031]The Fourier-spectrum outputting part 10 by comparing the data of the standard Fourier spectrum set as each arrangement substitution picture at the storage parts store of the Fourier-spectrum outputting part 10 beforehand corresponding to the data of the Fourier spectrum extracted by the Fourier-spectrum extraction part 9 by a comparison meansThe result of "1"the binarization data of "0"or either of "non-Shinsei" is outputted.
[0032]the data of the Fourier spectrum extracted by the Fourier-spectrum extraction part 9 being displayed on displayssuch as CRT and a liquid crystal displayor in the identification information extracting apparatus 2After providing the information which can output and view the data of the Fourier spectrum extracted by the Fourier-spectrum extraction part 9 using output unitssuch as a printer and a printing machineattestation of the printed matter by viewing can also be enabled.
[0033]The identification information collating unit possesses a collation means and memory storageand compares with memory storage the binarization data of n bit outputted from the Fourier-spectrum outputting part 10 by the standard identification information data and the collation means which are memorized beforehand. By this collationit is judged whether predetermined identification information is given to printed matterand attestation of printed matter is performed.
[0034](Operation of an identification information embedding device) The flow chart

shown in drawing 4 explains an operation of the example of the identification information embedding device in the printed matter authentication device concerning this inventionand an identification information extracting apparatus. Drawing 4 (a) is a flow chart of the processing in the identification information embedding device 1 of drawing 2and drawing 4 (b) is a flow chart of the processing in the identification information extracting apparatus 2 of drawing 2.

[0035]Firstan identification information embedding routine is explained in drawing 4 (a). In step 100an original image is read and it changes into digital image data. In Step 101binarization of the digital image data of the incorporated original image is carried outand a binary picture is created. In Step 102a binary picture is expanded to two times in all directionsrespectivelyand the expansion picture Fgt (xy) is created.

[0036]In Step 103two kinds of arrangement substitution pictures are created in each arrangement which divided Fgt (xy) into 2x2 pixel units by changing the number of the white picture element of the value of 1and arrangement in accordance with a predetermined arrangement substitution rule.

[0037]Drawing 3 is a figure showing the 2x2-pixel arrangement defined under the predetermined arrangement substitution rule concerning this invention. Fst (xy) (t= 12...) and the second arrangement substitution picture are made [an expansion picture] into F'st (xy) (t= 12...) for Fgt (xy) (t= 12...) and the first arrangement substitution picture. Each arrangement which divided Fgt (xy) into 2x2 pixel units is certainly either C1 or C2.

[0038]After an arrangement permutation means transposes C1 to C3 in each arrangement which divided Fgt (xy) into 2x2 pixel unitsC2 is transposed to C4Fst (xy) is createdafter transposing C1 to C3 in each arrangement which divided Fgt (xy) into 2x2 pixel unitsC2 is transposed to C5 and F'st (xy) is created. Since arrangement of the white picture element of the value of 1 differs mutuallyit is possible to embed 1 bit of identification information at Fst (xy) and F'st (xy) at C5 in C4 and F'st (xy) in Fst (xy).

[0039]In Step 104by outputting the image data of either Fst (xy) or F'st (xy) using devicessuch as a printer and a printing machinethe printed matter in which identification information was embedded is producedand an identification information embedding routine is ended.

[0040]Drawing 5 is a figure showing an example of the printed matter in which the identification information concerning this invention was embedded. In viewingthe difference between Fs1 (xy) of drawing 5 (a) and F's1 (xy) of drawing 5 (b) cannot be recognized easily.

[0041]By the wayin the printed matter authentication device concerning this inventionone image data printed by printed matter provides 1 bit of identification information. After printing one image data on the predetermined substrate and embedding 1 bit of identification information at printed matter1 bit of identification information can also be extracted and compared from printed matterand after printing two or more image data on the predetermined substrate and embedding two or more bits identification information at printed mattertwo or more bits

identification information can also be extracted and compared from printed matter. Anywayin the printed matter authentication device concerning this invention2n a kind (n bit) of identification information can be embedded at the printed matter produced by outputting n image data on a predetermined substrate.
[0042]Thusafter embedding identification information at printed matterin order to make it possible to extract and compare identification information from printed matterthe following composition is adopted by this invention. Namelythe embedding device of identification information is provided with the image input partthe pretreatment partthe arrangement substitution partand the image output partand said image input partChange the inputted image data respectively corresponding to n original image data into digital image datarespectivelyinput n digital image dataand said pretreatment partAfter carrying out binarization of said n digital image datarespectively and creating n binary picturesExpand said n binary pictures in all directions for predetermined magnificationrespectivelycreate n expansion picturesand said arrangement substitution partBy creating two kinds of arrangement substitution pictures for every expansion picture of said n expansion picturesEmbed 1 bit of identification information in each kind of two kinds of said arrangement substitution pictures of arrangement substitution pictureand said image output partBy outputting the image data of the arrangement substitution picture of one kind of said two kinds of arrangement substitution pictures for every expansion picture of said n expansion picturesand printing n arrangement substitution picturesthe printed matter which embedded the identification information of n bit in total is produced. Hereall of each original image data of n original image data can also be constituted so that it may become the same original image databut it is not necessary to constitute all of each original image data of n original image data so that it may become the same original image data. Drawing 1 shows the case where print four arrangement substitution picture I – NI as n= 4and 4-bit identification information is embedded.
[0043]An identification information extraction routine is explained using (an operation of an identification information recognition device)next drawing 4 (b). In Step 200an arrangement substitution picture is read in the printed matter in which identification information was embeddedand it changes into digital image data. In Step 201Fast Fourier Transform of the arrangement substitution picture changed into digital image data is carried out.
[0044]In Step 202a Fourier spectrum is extracted from the digital data obtained by carrying out Fast Fourier Transform of the arrangement substitution picture. By comparing the data of the standard Fourier spectrum set as each arrangement substitution picture in Step 203 at the storage parts store of the Fourier-spectrum outputting part beforehand corresponding to the data of the extracted Fourier spectrum by a comparison meansThe result of "1"the binarization data of "0"or either of "non-Shinsei" is outputtedand an identification information extraction routine is ended. the data of the Fourier spectrum extracted by the Fourier-spectrum extraction part being displayed on displayssuch as CRT and a liquid crystal displayor in an identification information extraction routineAfter

providing the information which can output and view the data of the Fourier spectrum extracted by the Fourier-spectrum extraction part using output unitssuch as a printer and a printing machineattestation of the printed matter by viewing can also be enabled.

[0045]Drawing 6 is a figure showing an example which outputted the Fourier spectrum about the image data of each printed matter of drawing 5 concerning this invention using the printer. |fs1(uv)| of drawing 6 (a) is a Fourier spectrum of Fs1 (xy) of drawing 5 (a)and the pattern of a circle configuration or semicircle shape is perpendicularly located in a line. On the other handalthough |f's1(uv)| of drawing 6 (b) is a Fourier spectrum of F's1 (xy) of drawing 5 (b)the pattern of a circle configuration or semicircle shape is horizontally located in a line.

[0046]By thus|fs1(uv)| and |f's1(uv)|. Since the deviations (bias of a direction) of a Fourier spectrum differin a comparison means to mention laterpattern recognition is easily possibleand viewing can also recognize easily the difference between |fs1(uv)| and |f's1(uv)|. Thereforeit is possible to extract 1 bit of identification information embedded Fs1 (xy) and F's1 (xy).

[0047]Drawing 7 is a figure showing expansion picture Fg2 (xy) which has a circular patternits first arrangement substitution picture Fs2 (xy)and the second arrangement substitution picture F's2 (xy). In viewingthe difference between Fs2 (xy) and F's2 (xy) cannot be recognized.

[0048]Drawing 8 is a figure showing Fourier-spectrum |fs2(uv)| of Fs2 (xy) of drawing 7 (b)and Fourier-spectrum |f's2(uv)| of F's2 (xy) of drawing 7 (c). | Since the deviations of a Fourier spectrum differ about fs2(uv)| and |f's2(uv)|in a comparison means to mention the difference latercomparison of a pattern is easily possibleand viewing can also be recognized easily. Thereforeit is possible to extract identification information from arrangement substitution picture Fs2 (xy) where identification information was embeddedand F's2 (xy).

[0049]Drawing 9 is a figure showing Fs2 (xy) of drawing 7 (b)and the two pictures Fa2 (xy) and Fb2 (xy) which constitute it. Fa2 (xy) is the picture which packed C3and it is a picture of Fs2 (xy) and the same size. Fb2 (xy) is the difference image which deducted Fs2 (xy) to Fa2 (xy)and the relation between each picture is given by several 1.

[0050]

[Equation 1]Fs2(xy)=Fa2(xy)+Fb2(xy) [0051]Drawing 10 is a figure showing F's2 (xy) of drawing 7 (c)two picture F'a2 (xy) which constitute itand F'b2 (xy). The relation between each picture is given by several 2.

[0052]

[Equation 2]F's2(xy)=F'a2(xy)+F'b2(xy) [0053]Howeverseveral 3 is realized between F'a2 (xy) and Fa2 (xy).

[0054]

[Equation 3]F'a2(xy)=Fa2(xy)[0055]Drawing 11 is a figure showing the Fourier spectrum of each picture of drawing 9. The center of each Fourier spectrum is a dc component because of an optical display. The domain of each Fourier spectrum is set to DR1. DR1 is a field which fills $-1/-1/2 <= u < 1/2$and $2 <= v < 1/2$. The line

and u of v=1/2 = since one half of sequences are not included in DR1as for |fa2(uv)|in coordinates (uv)a Fourier spectrum appears in four points(−1/2−1/2)(0−1/2)(−1/20)and (00). These four points are set to domain DR2. The domain except DR1 to DR2 is set to DR3. In DR3since it is |fa2(uv)|=0in DR3fa2(uv)=0 is realized. From the additivity rule of the Fourier transformseveral 4 is realized in DR3.
[0056]
[Equation 4]fs2(uv)=fb2(uv)[0057]As a resultseveral 5 is realized in DR3.
[0058]
[Equation 5]|fs2(uv)|=|fb2(uv)| [0059]Drawing 12 is a figure showing the Fourier spectrum of each picture of drawing 10. Herethe relation between |f'a2(uv)| and |fa2(uv)| is given by several 6.
[0060]
[Equation 6]|f'a2(uv)|=|fa2(uv)| [0061]Several 7 is realized in DR3.
[0062]
[Equation 7]|f's2(uv)|=|f'b2(uv)| [0063]| Although the influence of fa2(uv)| appears in DR2 of |fs2(uv)| and the influence of |f'a2(uv)| appears in DR2 of |f's2(uv)|the rate of DR2 occupied to DR1 is very small. Thereforein DR3 which occupies the great portion of DR1from several 5 and several 7 being realized. | The main element which makes Fourier−spectrum distribution of fs2(uv)| produce a deviation is |fb2(uv)|and it turns out that the main element which makes Fourier−spectrum distribution of |f's2(uv)| produce a deviation is |f'b2(uv)|.
[0064]Since Fs2 (xy) comprises C3 and C4in space image Fb2 (xy) of |fb2(uv)|2−pixel or more (multiple of 2) continuation of the white picture element of the value of 1 of the line whose total pixel value is not 0 is carried outand it appears. On the other handabout each sequence of Fb2 (xy)the neighbors of the white picture element of the value of 1 certainly become a black pixel of the value of 0 in the sequence whose total pixel value is not 0. For this reasonthe deviation for |fb2(uv)| to have a small rate of the Fourier spectrum which exists in the high frequency region (1/4<=u<1/2) of u shaft orientationsand for the rate of the Fourier spectrum which exists in the high frequency region (1/4<=v<1/2) of v shaft orientations to be large is shown.
[0065]Since F's2 (xy) comprises C3 and C5in space image F'b2 (xy) of |f'b2(uv)|a total pixel value carries out 2−pixel or more (multiple of 2) continuation of the white picture element of the value of 1 of the sequence which is not 0and it appears. On the other handabout each line of F'b2 (xy)the neighbors of the white picture element of the value of 1 certainly become a black pixel of the value of 0 in the line whose total pixel value is not 0.
[0066]For this reasondeviation for |f'b2(uv)| to have a small rate of a Fourier spectrum which exists in a high frequency region (1/4<=v<1/2) of v shaft orientationsand for a rate of a Fourier spectrum which exists in a high frequency region (1/4<=u<1/2) of u shaft orientations to be large is shown. | By fb2(uv)| and |f'b2(uv)|since deviations of a Fourier spectrum differit becomes possible to extract identification information from an arrangement substitution picture where identification information was embedded.

[0067]Although it has composition which extracts identification information of n bit embedded at printed matter as above-mentionedand is compared in this inventionthis specifically becomes possible by composition of an identification information recognition device shown in drawing 13.
[0068]Namelyan identification information recognition device comprises an identification information collating unit which compares identification information of an identification information extracting apparatus which extracts identification information of n bitand said extracted n bit with standard identification information data of n bit memorized beforehandAn identification information extracting apparatus is provided with an image read sectionthe Fast Fourier Transform parta Fourier-spectrum extraction partand a Fourier-spectrum outputting partand an image read sectionChange into digital image data image data of n arrangement substitution pictures read in printed matterrespectivelyand n digital image data is generatedThe Fast Fourier Transform parta Fourier-spectrum extraction partand a Fourier-spectrum outputting partn digital image data generated by an image read section is processedrespectivelyAn identification information embedding device extracts identification information of n bit from printed matter using a Fourier spectrum of each kind of two kinds of arrangement substitution pictures created for every original image data of n original image data of arrangement substitution picture having a mutually different deviationAn identification information collating unit compares standard identification information data of identification information of n bitand n bit extracted with an identification information extracting apparatusWhen a predetermined relation between identification information of n bit and standard identification information data of n bit issaid printed matter is identified as genuine printed matter.
[0069]A Fourier-spectrum outputting part in an identification information extracting apparatusBy comparing data of a standard Fourier spectrum set as each arrangement substitution picture at a storage parts store of a Fourier-spectrum outputting part beforehand corresponding to data of an extracted Fourier spectrum by a comparison meansA result of "1"binarization data of "0"or either of "non-Shinsei" is outputted.
[0070]If this point is explained in full detaila Fourier-spectrum outputting part possesses a storage parts store and a comparison meansand data of a standard Fourier spectrum is beforehand memorized by storage parts store. And data of a Fourier spectrum extracted by a Fourier-spectrum extraction part is compared in data and a comparison means of a standard Fourier spectrum. Data of |fst(uv) | and |f'st(uv) | is specifically beforehand memorized by storage parts store1is outputted when data of an extracted Fourier spectrum corresponds to |fst(uv) |It is constituted so that a signal meaning an unauthorized use may be outputtedwhen "0" is outputted when data of an extracted Fourier spectrum corresponds to |f'st(uv) |and data of an extracted Fourier spectrum corresponds to neither.
[0071]data of a Fourier spectrum extracted by a Fourier-spectrum extraction part being displayed on displayssuch as CRT and a liquid crystal displayor in an identification information recognition deviceAfter providing information which can

output and view data of a Fourier spectrum extracted by a Fourier-spectrum extraction part using output unitssuch as a printer and a printing machineattestation of printed matter by viewing can also be enabled.
[0072]An identification information collating unit possesses a collation means and memory storageand compares with memory storage binarization data of n bit outputted from a Fourier-spectrum outputting part of an identification information extracting apparatus by standard identification information data and a collation means which are memorized beforehandWhen a predetermined relation between standard identification information data beforehand memorized by binarization data and memory storage of n bit outputted from a Fourier-spectrum outputting part of an identification information extracting apparatus isprinted matter is attested as genuine printed matter.
[0073]For examplewhen a printed matter authentication device of this invention is used as an authentication device of a pass permit0101is beforehand stored in memory storage of an identification information collating unit as standard identification information dataWhen binarization data outputted from a Fourier-spectrum outputting part of an identification information extracting apparatus as identification information embedded at a pass permit is in agreement with "0101" which is standard identification information datathere is also the method of use whose passing is enabled.
[0074]As mentioned abovealthough an embodiment of a printed matter authentication device concerning this invention has been described based on a concrete exampleA mode of operation of a printed matter authentication device concerning this invention is not limited to the above-mentioned exampleand if it is within the limits of a technical matter indicated to a claim concerning this inventionit can adopt various kinds of modes. Although especially a case where created two kinds of arrangement substitution pictures from an expansion picture acquired in the above-mentioned example by expanding a binary picture corresponding to original image data to two times in all directionsrespectivelyand 1 bit of identification information was embedded in each kind of two kinds of arrangement substitution pictures of arrangement substitution picture was explainedIn accordance with a predetermined arrangement substitution ruletwo kinds of arrangement substitution pictures are created from an expansion picture acquired by expanding a binary picture corresponding to original image data for predetermined magnification for every directionIt is also possible by embedding 1 bit of identification information in each kind of two kinds of arrangement substitution pictures of arrangement substitution picture to constitute a printed matter authentication device of this invention. In producing printed matter which printed n arrangement substitution pictures in an identification information embedding deviceand embedded identification information of n bitextracting said predetermined characteristic which said ink shows under said predetermined conditions in an identification information extracting apparatusafter printing an arrangement substitution picture of a piece at least using ink in which the predetermined characteristic is shown under predetermined conditions -- said --

image data of an arrangement substitution picture of a piece may be read at least.
[0075]
[Effect of the Invention]The printed matter authentication device concerning this invention is a binary picture by which the white picture element of the value of 1 and the black pixel of the value of 0 have been arranged in accordance with a predetermined arrangement substitution ruleSince identification information is extracted from the printed matter produced by outputting the binary picture where predetermined identification information was embedded on a predetermined substrateAfter [which is depended on the density unevenness of inkor time progress compared with the case where identification information is extracted from the shade image of printed matter] having fadedbeing hard to be influenced by illumination unevenness etc.being stabilized from printed matter and extracting identification informationit becomes possible to attest printed matter correctly. Since identification information is embedded in the printed matter authentication device concerning this invention at the whole binary picture which comprises a white picture element of the value of 1and a black pixel of the value of 0 using a phase modulationThe embedded domain of identification information is not restricted by the pattern like [in the case of embedding identification information at printed matter using frequency modulation].
[0076]In the printed matter authentication device concerning this inventionsince identification information is extracted using the deviation which appears in the Fourier spectrum of the image data read in the printed matter in which identification information was embeddedwhen extracting identification information from printed matterhighly precise alignment is not needed. In the printed matter authentication device concerning this inventionsince it is not necessary to necessarily carry out binarization of the image data read in an image scannera video cameraetc. when extracting identification information from printed matterit is hard to receive the fall of the sharpness of image data and the influence of illumination unevenness which were read. For this reasonin the printed matter authentication device concerning this inventionit becomes possible to be stabilized conventionally and to attest printed matter correctly.
[0077]The printed matter authentication device concerning this invention by creating two kinds of arrangement substitution pictures for every original image data of n original image data1 bit of identification information is embedded in each kind of two kinds of arrangement substitution pictures of arrangement substitution pictureand since it becomes possible from printed matter to extract and compare the identification information of n bitit becomes possible to attest printed matter correctly using more identification information. And the printed matter in which the identification information produced using the printed matter authentication device concerning this invention was embeddedIt is a binary picture by which the white picture element of the value of 1 and the black pixel of the value of 0 have been arranged in accordance with a predetermined arrangement substitution ruleSince it is the printed matter which printed the binary picture where predetermined identification information was embedded simple to various mediasuch as papera

plasticmetaland clothusing various output unitssuch as a printer and a printing machineThe printed matter authentication device of this invention can be used for the various field which requires discernment of the printed matter containing a securitya billa stampan inspection stickera stampa passportan identification carda pass permita membership cardand a credit cardand truth distinction.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1]The figure for explaining the entire configuration of the example of the printed matter authentication device concerning this invention.
[Drawing 2]The block diagram showing an example of an identification information embedding device and an identification information extracting apparatus.
[Drawing 3]The figure showing the 2x2-pixel arrangement defined under the arrangement substitution rule.
[Drawing 4]The flow chart explaining the embedding and the extraction method of identification information.
[Drawing 5]The figure showing an example of the printed matter in which identification information was embedded.
[Drawing 6]The figure showing an example which outputted the Fourier spectrum about the image data of each printed matter of drawing 5 using the printer.
[Drawing 7]The figure showing expansion picture Fg2 (xy) which has a circular patternits first arrangement substitution picture Fs2 (xy)and the second arrangement substitution picture F's2 (xy).
[Drawing 8]The figure showing Fourier-spectrum |fs2(uv)| of Fs2 (xy) of drawing 7 (b)and Fourier-spectrum |f's2(uv)| of F's2 (xy) of drawing 7 (c).
[Drawing 9]The figure showing Fs2 (xy) of drawing 7 (b)and the two pictures Fa2 (xy) and Fb2 (xy) which constitute it.
[Drawing 10]The figure showing F's2 (xy) of drawing 7 (c)and two picture F'a2 (xy) and F'b2 which constitute it (xy).
[Drawing 11]The figure showing the Fourier spectrum of each picture of drawing 9.
[Drawing 12]The figure showing the Fourier spectrum of each picture of drawing 10.
[Drawing 13]The figure explaining the identification information recognition device of this invention.
[Description of Notations]
1 Identification information embedding device
2 Identification information extracting apparatus
3 Image input part
4 Pretreatment part
5 Arrangement substitution part
6 Image output part
7 Image read section

8 Fast Fourier Transform part
9 Fourier-spectrum extraction part
10 Fourier-spectrum outputting part
11 Original image
12 Printed matter in which identification information was embedded